SPICE TOOL
METHODOLOGICAL APPENDIX

SPICE, co-founded by L'ORÉAL & Quantis

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1. Introduction

1.1. Context

SPICE is an initiative that brings together organizations in the cosmetics industry to work towards a common goal: **to shape the future of sustainable packaging**. SPICE develops business-oriented methodologies and data to support resilient decisions along the entire packaging value chain.

1.2. Purpose of the document

The purpose of this document is to present data and assumptions used in the SPICE Tool.

For an overview of the SPICE Methodology, please read the latest version of the SPICE Methodological Guidelines available online at: open-spice.com/publications

2. Methodology

2.1. Impact categories and LCIA methods

Source: PEF Guidance document, version 6.3 as published in April 2018.

Table 1 – Impact categories and LCIA methods used in the SPICE Tool

Impact category	Indicator	Unit	LCIA method
Climate change	Radiative forcing as Global Warming Potential (GWP100)	kg CO_2 eq	Baseline model of 100 years of the IPCC (based on IPCC 2013)
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 eq	Steady-state ODPs as in (WMO 1999)
Human toxicity, cancer	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model (Rosenbaum et al, 2008)
Human toxicity, non-cancer	Comparative Toxic Unit for humans (CTUh)	CTUh	USEtox model (Rosenbaum et al, 2008)
Particulate matter	Impact on human health	disease incidence	PM method recommended by UNEP (UNEP 2016)
Ionizing radiation, human health	Human exposure efficiency relative to U^{235}	kBq U^{235} eq	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)
Photochemical ozone formation	Tropospheric ozone concentration increase	kg NMVOC eq	LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008
Acidification	Accumulated Exceedance (AE)	mol H^+ eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N eq	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P eq	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N eq	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe
Ecotoxicity, freshwater	Comparative Toxic Unit for ecosystems (CTUe)	CTUe	USEtox model (Rosenbaum et al, 2008)
Land use	Soil quality index (covering Biotic production, Erosion resistance, Mechanical filtration and Groundwater replenishment)	Dimensionless (pt) (synthesis of kg biotic production,	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)

Impact category	Indicator	Unit	LCIA method
		kg soil, m^3 water, m^3 groundwater)	
Water use	User deprivation potential (deprivation-weighted water consumption)	m^3 world eq	Available WAter REmaining (AWARE) as recommended by (UNEP, 2016)
Resource use, minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb eq	CML 2002 (Guinée et al., 2002) and (van Oers et al. 2002)
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ	CML 2002 (Guinée et al., 2002) and (van Oers et al. 2002)

2.2. Normalization and weighting factors for single score calculation

In addition to individual impact categories, the SPICE Tool provides an environmental single score. This environmental single score aims at facilitating decision making but does not replace the set of indicators.

2.2.1. Global normalization values

The normalization values used in the SPICE Tool are representative of the yearly impact on Earth for each indicator, divided by the world population.

Source: PEF Guidance 6.3, Annex B.1, as published in April 2018.

Table 2 – Normalization values used in the SPICE Tool

Impact category	Normalization value	Unit
Normalization value for Climate Change	7760	kg CO_2-eq per person
Normalization value for Ozone Depletion	2.34E-02	kg CFC-11 eq per person
Normalization value for Ionizing Radiation	4220	kg U^{235} eq (to air) per person
Normalization value for Photochemical Ozone Formation	40.6	kg NMVOC-eq per person
Normalization value for Particulate Matter	0.000637	disease inc. per person
Normalization value for Human Toxicity, non-cancer	4.75E-04	CTUh per person
Normalization value for Human Toxicity, cancer	3.85E-05	CTUh per person
Normalization value for Acidification	55.5	mol H^+ eq per person
Normalization value for Freshwater Eutrophication	2,55	kg P-eq per person
Normalization value for Marine Eutrophication	28.3	kg N-eq per person
Normalization value for Terrestrial Eutrophication	177	mol N-eq per person
Normalization value for Ecotoxicity	11800	CTUe per person
Normalization value for Land Transformation	1330000	Pt per person
Normalization value for Resource Depletion, energy carriers	65300	MJ per person
Normalization value for Resource Depletion, mineral and metals	0.0579	kg Sb-eq per person
Normalization value for Water Scarcity	11500	m^3 of water - eq per person

2.2.2. Planetary Boundaries weighting factors

The weighting factors used in the SPICE Tool have been developed based on the concept of "Planetary Boundaries". For each impact category, the yearly level of impact is compared to the limit of the planet. The higher above the limit, the more weight the indicator will have, and conversely.

Note: The SPICE Tool uses the Planetary Boundaries weighting factors, however the SPICE Methodological Guidelines allows to use either the Planetary Boundaries weighting factor or the Panel-based values (as proposed by the PEF).

Source: Vargas et al. – Operational Life Cycle Impact Assessment weighting factors based on Planetary Boundaries: Applied to cosmetic products, Ecological Indicators, Volume 107, 2019, available at: https://doi.org/10.1016/j.ecolind.2019.105498

Table 3 – Weighting factors used in the SPICE Tool

Impact category	Weighting Factor	Unit
Weighting Factor for Climate Change	21.86%	dimensionless (%)
Weighting Factor for Ozone Depletion	0.65%	dimensionless (%)
Weighting Factor for Ionizing Radiation	0.035%	dimensionless (%)
Weighting Factor for Photochemical Ozone Formation	1.26%	dimensionless (%)
Weighting Factor for Particulate Matter	13.93%	dimensionless (%)
Weighting Factor for Human Toxicity, non-cancer	2.10%	dimensionless (%)
Weighting Factor for Human Toxicity, cancer	0.62%	dimensionless (%)
Weighting Factor for Acidification	1.24%	dimensionless (%)
Weighting Factor for Freshwater Eutrophication	7.53%	dimensionless (%)
Weighting Factor for Marine Eutrophication	1.29%	dimensionless (%)
Weighting Factor for Terrestrial Eutrophication	0,71%	dimensionless (%)
Weighting Factor for Ecotoxicity	1.98%	dimensionless (%)
Weighting Factor for Land Transformation	21.80%	dimensionless (%)
Weighting Factor for Resource Depletion, energy carriers	4.49%	dimensionless (%)
Weighting Factor for Resource Depletion, mineral and metals	19.33%	dimensionless (%)
Weighting Factor for Water Scarcity	1.20%	dimensionless (%)

3. Data

3.1. Underlying database

The SPICE Tool uses ecoinvent database (version 3.5) for generic activities (materials, processes, transport, electricity consumption etc.)

In addition to the ecoinvent datasets, some activities (materials and processes) have been developed by the SPICE initiative (or granted by SPICE members to the SPICE initiative). In order to keep consistency across the SPICE Tool database, these specific datasets have built on the same version of ecoinvent.

3.2. Transport scenarios

Source: Average values representative of surveyed SPICE Corporate Members, 2020

Table 4 – Transport scenarios used in the SPICE Tool

Transport scenario	Distance by Truck (km)	Distance by Train (km)	Distance by Boat (km)	Distance by Plane (km)
Europe <-> Europe	1165	151	17	1
Europe <-> Asia	797	15	14771	345
Europe <-> North America	1136	167	6889	422
Europe <-> South America	859	10	9042	578
Europe <-> Africa	695	10	5053	294
Europe <-> Middle East	683	10	4218	231
Asia <-> Asia	621	6	3975	90
Asia <-> North America	1211	163	11763	329
Asia <-> South America	1020	6	18817	533
Asia <-> Africa	672	6	6592	194
Asia <-> Middle East	827	6	6592	192
North America <-> North America	1998	411	560	24
North America <-> South America	1249	157	6172	402
North America <-> Africa	902	157	10908	654
North America <-> Middle East	902	157	58892	592
South America <-> South America	789	0	17455	341
South America <-> Africa	711	0	11566	708
South America <-> Middle East	711	0	11566	708
Africa <-> Africa	312	0	1928	12

Transport scenario	Distance by Truck (km)	Distance by Train (km)	Distance by Boat (km)	Distance by Plane (km)
Africa <-> Middle East	312	0	1928	12
Middle East <-> Middle East	246	0	1928	9
Global <-> Global	848	68	10030	318
Global <-> Europe	834	42	7995	374
Global <-> Asia	905	39	11707	319
Global <-> North America	1080	160	18925	480
Global <-> South America	910	34	11433	586
Global <-> Africa	658	34	7209	372
Global <-> Middle East	687	34	16639	347
Generic upstream transport scenario (from Raw Material Producer to Manufacturing site)	500	0	0	0

3.3. End-of-life scenarios

Sources:

- Europe: European Commission, PEF Guidance 6.3, Annex C (Annex C_CFF_Default Parameters_October2019.xlsx)
- USA: US EPA
- Canada: Statcan
- Other zones: UN stats

Note: if the user specifies a country as the "Sales zone", the zone that corresponds to the country is considered (e.g., if France is selected, the European scenario is applied).

Table 5 – End of life scenarios by Zone and Material Group

Zone	Material Group Name	Recycling	Incineration (with energy recovery)	Incineration (without energy recovery)	Landfilling	Efficiency factor of energy recovery - electricity	Efficiency factor of energy recovery - heat
		(%)	*(%)*	*(%)*	*(%)*	*dimensionless*	*dimensionless*
Europe	Glass	66%	19%	0%	15%	0.10	0.31
Europe	Steel	74%	15%	0%	12%	0.10	0.31
Europe	Aluminium	69%	17%	0%	14%	0.10	0.31
Europe	Wood	30%	39%	0%	32%	0.10	0.31
Europe	Paper and cardboard	75%	14%	0%	11%	0.10	0.31
Europe	PE	29%	39%	0%	32%	0.10	0.31
Europe	PP	29%	39%	0%	32%	0.10	0.31
Europe	PET	42%	32%	0%	26%	0.10	0.31
Europe	No recycling	0%	55%	0%	45%	0.10	0.31
Africa	Glass	0%	0%	1%	99%	0.10	0.31

Zone	Material Group Name	Recycling	Incineration (with energy recovery)	Incineration (without energy recovery)	Landfilling	Efficiency factor of energy recovery - electricity	Efficiency factor of energy recovery - heat
		(%)	*(%)*	*(%)*	*(%)*	*dimensionless*	*dimensionless*
Africa	Steel	0%	0%	1%	99%	0.10	0.31
Africa	Aluminium	0%	0%	1%	99%	0.10	0.31
Africa	Wood	0%	0%	1%	99%	0.10	0.31
Africa	Paper and cardboard	0%	0%	1%	99%	0.10	0.31
Africa	PE	0%	0%	1%	99%	0.10	0.31
Africa	PP	0%	0%	1%	99%	0.10	0.31
Africa	PET	0%	0%	1%	99%	0.10	0.31
Africa	No recycling	0%	0%	1%	99%	0.10	0.31
Asia	Glass	2%	9%	0%	89%	0.10	0.31
Asia	Steel	4%	7%	0%	89%	0.10	0.31
Asia	Aluminium	4%	7%	0%	89%	0.10	0.31
Asia	Wood	4%	7%	0%	89%	0.10	0.31
Asia	Paper and cardboard	1%	10%	0%	89%	0.10	0.31
Asia	PE	2%	9%	0%	89%	0.10	0.31
Asia	PP	2%	9%	0%	89%	0.10	0.31
Asia	PET	2%	9%	0%	89%	0.10	0.31
Asia	No recycling	0%	10%	1%	90%	0.10	0.31
Middle East	Glass	0%	0%	12%	88%	0.10	0.31
Middle East	Steel	0%	0%	12%	88%	0.10	0.31
Middle East	Aluminium	0%	0%	12%	88%	0.10	0.31
Middle East	Wood	0%	0%	12%	88%	0.10	0.31
Middle East	Paper and cardboard	0%	0%	12%	88%	0.10	0.31

Zone	Material Group Name	Recycling	Incineration (with energy recovery)	Incineration (without energy recovery)	Landfilling	Efficiency factor of energy recovery - electricity	Efficiency factor of energy recovery - heat
		(%)	*(%)*	*(%)*	*(%)*	*dimensionless*	*dimensionless*
Middle East	PE	0%	0%	12%	88%	0.10	0.31
Middle East	PP	0%	0%	12%	88%	0.10	0.31
Middle East	PET	0%	0%	12%	88%	0.10	0.31
Middle East	No recycling	0%	0%	12%	88%	0.10	0.31
North America	Glass	21%	9%	0%	70%	0.10	0.31
North America	Steel	25%	8%	0%	67%	0.10	0.31
North America	Aluminium	25%	8%	0%	67%	0.10	0.31
North America	Wood	10%	10%	0%	80%	0.10	0.31
North America	Paper and cardboard	43%	4%	0%	53%	0.10	0.31
North America	PE	7%	11%	0%	82%	0.10	0.31
North America	PP	7%	11%	0%	82%	0.10	0.31
North America	PET	7%	11%	0%	82%	0.10	0.31
North America	No recycling	0%	12%	0%	88%	0.10	0.31
South America	Glass	6%	0%	0%	94%	0.10	0.31
South America	Steel	6%	0%	0%	94%	0.10	0.31
South America	Aluminium	6%	0%	0%	94%	0.10	0.31
South America	Wood	6%	0%	0%	94%	0.10	0.31
South America	Paper and cardboard	6%	0%	0%	94%	0.10	0.31
South America	PE	6%	0%	0%	94%	0.10	0.31
South America	PP	6%	0%	0%	94%	0.10	0.31
South America	PET	6%	0%	0%	94%	0.10	0.31
South America	No recycling	0%	0%	5%	95%	0.10	0.31

Zone	Material Group Name	Recycling	Incineration (with energy recovery)	Incineration (without energy recovery)	Landfilling	Efficiency factor of energy recovery - electricity	Efficiency factor of energy recovery - heat
		(%)	*(%)*	*(%)*	*(%)*	*dimensionless*	*dimensionless*
Global	Glass	9%	7%	1%	83%	0.10	0.31
Global	Steel	11%	6%	1%	83%	0.10	0.31
Global	Aluminium	11%	6%	1%	83%	0.10	0.31
Global	Wood	7%	8%	1%	84%	0.10	0.31
Global	Paper and cardboard	11%	7%	1%	81%	0.10	0.31
Global	PE	5%	9%	1%	85%	0.10	0.31
Global	PP	5%	9%	1%	85%	0.10	0.31
Global	PET	5%	9%	1%	85%	0.10	0.31
Global	No recycling	0%	11%	1%	88%	0.10	0.31

3.4. Energy recovery rates

Source for efficiency factors of energy recovery: European Commission, PEF Guidance 6.3, Annex C (Annex C_CFF_Default Parameters_October2019.xlsx)

Table 6 – Default values for energy recovery rates

Type of energy recovery	Recovery rate
Efficiency factor of energy recovery – electricity	10%
Efficiency factor of energy recovery – heat	31%

3.5. Tertiary Packaging default data

Source: Average values representative of surveyed SPICE Corporate Members, 2020.

Table 7 – Default values for tertiary packaging

Component	Quantity	Unit
Plastic film	0.005	g per g of transported item
Corrugated cardboard	0.167	g per g of transported item
Wood pallet	0.298	g per g of transported item

3.6. Pump average composition

Source: Average values representative of surveyed SPICE Corporate Members, 2020.

In addition to the Materials listed in the following table, a process of plastic injection is also included in the generic pump model.

Table 8 – Breakdown (in mass) by material for an average pump

Material	%
PP	49.9%
HDPE	11.7%
LDPE	2.2%
PET	0.6%
Stainless steel	10.1%
POM	7.9%
Glass	0.2%
EVA	0.1%
ABS	15.5%
Rubber	0.4%
PCT	0.5%
Aluminium, anodized	0.8%

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